Finishes for interior concrete floors

Cement and Concrete Association

The information given in this booklet relates to the surface finish of concrete floors laid in buildings. Outside paving and roads are dealt with in other publications issued by the Association.

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REQUIREMENTS FOR FLOOR FINISHES

Good quality concrete, well laid and finished, makes a satisfactory floor for most purposes. It is, however, sometimes necessary to give the floor a surface finish specially adapted to the conditions in which it will be used. The qualities required of such a finish will naturally vary according to the functions of the building, but they will certainly include in some degree one or more of the following :

(1) Resistance to abrasion
(2) Freedom from slipperiness
(3) Smoothness
(4) Low thermal conductivity
(5) Pleasant appearance
(6) Resistance to
    (*a*) Mineral oils
    (*b*) Vegetable oils
    (*c*) Mineral acids
    (*d*) Organic acids
    (*e*) Strong alkalis
(7) Ease of repair
(8) Low maintenance costs.

A summary of the main properties required for particular purposes is given in Table 1. Although this table is not comprehensive the range of uses listed should cover most purposes.

PROPERTIES OF VARIOUS FINISHES

The principal types of finish used on concrete floors, with indications of their main properties, are given in Table 2. The degree to which a particular finish possesses any given property depends, of course, on the quality of the materials used and the skill exercised in its construction. This is particularly true as regards appearance. The ratings given in Table 2 are based on the assumption that the finish is of good quality.

NOTES ON SPECIAL USES

The following notes are given in amplification of Tables 1 and 2.

Factories and workshops

Heavy engineering workshops require floors which will be unaffected by oil and will withstand the wear imposed by iron-tyred trolleys. Cutting oil may contain vegetable or animal oil which is slightly corrosive and it is therefore advisable to place trays beneath machine tools. The floor should be of good quality concrete and free from cracks, in order to prevent oil accidentally spilled penetrating to the ceiling below.

Where ordinary concrete is used as the general finish, the tracks or paths used by trolleys may be surfaced with special quality concrete (granolithic) in order to reduce wear.

Factories and workshops used for precision work such as manufacture of radio parts, require floors that are dustless, easy to clean and reasonably hard-wearing. Ordinary high grade concrete or granolithic is generally suitable for the purpose.

Food factories

Most fresh food products have no harmful effect on concrete, but oils and fats resulting from the processing of meat are acidic in nature, and may react with the free lime in hardened Portland cement causing surface pitting.

The products of fermentation or deterioration of foodstuffs are usually more corrosive than the fresh

TABLE 1: PROPERTIES REQUIRED FOR FLOOR FINISHES FOR VARIOUS PURPOSES

Type of floor	Resistance to abrasion	Freedom from slipperiness	Smoothness	Low thermal conductivity (warmness)	Appearance	Resistance to attack by					Ease of repair
						Mineral oil	Vegetable oil and fat	Mineral acid	Organic acid	Alkalis	
Factories and workshops											
(*a*) Heavy industries ..	xxxx	xxx	—	—	x	xxx	—	—	—	—	xxx
(*b*) Light industries ..	xxx	xxx	x	x	x	—	—	—	—	—	xx
Shops	xxx	xx	xx	x	xxx	—	—	—	—	—	x
Offices	xxx	xx	xx	xx	xx	—	—	—	—	—	xx
Domestic	xx	xx	xx	xxx	xxx	—	—	—	—	—	xx
Dance floors	xxx	—	xxx	—	xxx	—	—	—	—	—	x
Breweries and beer cellars	xxxx	xx	x	—	x	—	—	—	xxxx	—	xxx
Dairies	†	xx	x	—	x	—	—	—	xxxx	xxxx	xxx
Food factories	†	xxx	x	—	x	—	xxxx	—	xxx	xxxx	xxx
Chemical laboratories and factories	xx	xx	x	x	x	—	—	‡	‡	‡	xxx

KEY: xxxx = Very important
xxx = Important
xx = Required to some degree
x = Desirable
— = Not applicable
† = Variable, sometimes xxxx
‡ = xxxx according to chemicals used

materials. Thus fresh beer has no effect on concrete, but fermented beer may cause deterioration. Similarly, fresh milk is harmless, but the lactic acid and butyric acids in sour milk will eventually cause corrosion. Dry sugar is harmless to mature concrete, but hot or fermented solutions are dangerous.

Fruit juices and vinegar also have a corrosive effect on Portland cement. If the concentration is high the floor should be given an acid-resisting finish.

A well laid concrete floor is impermeable and waste products cannot penetrate it. They should, however, be laid to proper falls to assist in cleaning. Frequent washing down will not only ensure hygienic conditions, but will prevent the formation of harmful residues on the surface.

Generally, a hard-wearing concrete such as granolithic provides a suitable surface, though barrels, milk churns and similar heavy containers may cause serious local wear, in which case special precautions, such as the use of steel grids, may be required in some places.

Domestic floors

The main requirements for domestic floors are good thermal insulation and a pleasant appearance—requirements which necessitate the use of a special surfacing. In kitchens and bathrooms a coloured concrete surface polished with wax can be satisfactory, but concrete tiles are generally preferable.

Dance floors

Outdoor dance floors can be finished with granolithic concrete or terrazzo, waxed and polished. Paste or liquid wax should be used for the first two or three applications; alternatively, if the surface is really smooth a dressing with French chalk may be sufficient.

NOTES ON THE CONSTRUCTION OF STRUCTURAL FLOORS

FLOORS IN CONTACT WITH THE GROUND: The strength of a floor in contact with the ground depends on the uniformity and bearing capacity of the foundation. To ensure uniformity trenches or soft spots should be carefully filled and compacted and any tree roots or other obstructions should be removed. The floor should not be allowed to bear on the foundations

TABLE 2: CHIEF PROPERTIES OF DIFFERENT FLOOR FINISHES

Type of finish	Resistance to abrasion	Freedom from slipperiness	Smoothness	Low thermal conductivity (warmness)	Appearance	Resistance to attack by					Ease of Repair
						Mineral oil	Vegetable oil	Mineral acid	Organic acid	Alkalis	
Ordinary concrete ..	xxx	xxx	xxx	x	xx	xxx	xx	o	x	xxxx	x
Special surface concrete (granolithic)	xxxx	xxx	xxx	x	§	xxxx	xxx	o	x	xxxx	x
Terrazzo	xxx	xx	xxxx	x	xxxx	xxxx	xxx	o	x	xxxx	x
Concrete tiles	§	xxx	xxx	§	xxxx	xxxx	xxx	o	x	xxxx	xxxx
Granolithic slabs	xxxx	xxx	xxx	x	xxx	xxx	xxx	o	x	xxxx	xxxx
Cement-bitumen mixture	x	xxx	xxx	xx	xxx	x	x	xx	xx	xxxx	xx
Cement-latex mixture ..	x	xxx	xxx	xx	xx	xx	x	xx	xx	xxxx	xx
Cement-sawdust	x	xxx	xx	xxx	xx	xx	xx	o	x	xx	xx
Jointless composition (Magnesium oxychloride)	xx	xxx	xxx	xx	xxx	xxx	xxx	—	—	—	xx
Mastic asphalt	xxx	xx	xxx	xx	xx to xxx	x	x	xxxx	xxxx	x	xx
Pitch mastic	xx	xx	xxx	xx	xx	xx	x	xxxx	xxxx	x	xx
Composition tiles.. ..	§	§	§	§	§	§	§	§	§	§	§
Quarry tiles	xxx	xxx	xxx	x	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
Paving bricks	xxx	xxxx	xx	xx	xx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx
Linoleum and cork ..	x	xxx	xxxx	xxxx	xxxx	xxx	xxx	xxx	xxx	xx	xxxx
Rubber sheet or blocks ..	xxx	xx	xxxx	xxx	xxxx	x	x	xxx	xxx	xxx	xxxx
Steel grids	xxxx	xx	x	o	x	xxxx	xxxx	x	xxx	xxxx	xx
Timber	xx	xxx	xxxx	xxxx	up to xxxx	xxxx ¶	xxxx ¶	x	xxx	xx	xxxx

KEY: xxxx = Very good; xxx = Good; xx = Fair; x = Low; o = Poor; § = Variable according to type; ¶ = Easily discoloured

of walls, manholes or stanchions.

The filling should consist of a dry lean concrete or of hardcore, gravel or other granular material, compacted in 6 in. layers.

A strip of expansion joint material should be inserted between the edges of the floor and any solid structure or wall against which it abuts, to allow for lateral movement. If much liquid is likely to come in contact with the floor the joint should be sealed. The sealing compound employed will depend upon the nature of the liquid, but bituminous and rubber-based materials are often used.

If there is reason to expect an unusual amount of settlement or variation in temperature it is advisable to use reinforcement. This may be in the form of a wire mesh or a mat of mild steel bars weighing from 4 to 7 lb. per square yard, placed 2 in. below the surface and lapped for a length of about forty times the diameter of the wire or bar.

In domestic or other floors which depend for satisfactory results on freedom from damp, a damp-proof course should be inserted beneath the concrete. An effective way of doing this is to blind the surface of a hardcore or other filling with mortar or concrete and to cover it with a layer of bituminous sheeting with lapped and bonded joints. Pitch or tar, laid hot, is sometimes used. Mastic asphalt and pitch mastic finishes are waterproof in themselves and their use renders a

damp-proof course in the floor unnecessary.

Where a concrete finish is desired the floor may either be cast in one layer or in two courses, the top course being laid if possible at the same time. It is important that the two courses be thoroughly bonded together. The construction joints in the topping should coincide with those in the base course. Any joint formed in the base should be continued through the topping.

SUSPENDED FLOORS: Suspended floors, like those laid on the ground, may be either cast in one thickness or may consist of a structural concrete slab with a selected topping or finish either laid at the same time (this is preferable) or subsequently bonded to it. If the finish is laid when the base concrete has hardened, great care must be taken to ensure effective bonding of the two layers.

If a concrete topping is laid at the same time as the structural slab it is usual to make the total thickness of the floor and topping $\frac{1}{2}$ in. greater than that required by calculation. If the topping is laid subsequently, its thickness should be neglected in the design of the supporting slab.

Should the thickness of a concrete topping be more than about $1\frac{1}{2}$ in. it is advisable to incorporate some light reinforcement in it where the floor passes over any supporting beams or walls.

The bond between the topping and the structural floor is of the utmost importance if the surface is not to become loose when the floor deflects under load. In addition, differences in composition between the floor and the topping result in different rates of shrinkage which may cause warping or curling of the topping unless it is thoroughly bonded with the base concrete.

THE QUALITY OF CONCRETE: In any form of floor construction it is important that the concrete should be of high quality. The quality of concrete, and especially its strength, wear-resistance and impermeability, depend mainly on thorough compaction and the use of a dry mix.

The drier the mix, however, the more difficult it is to compact the concrete, and for this reason it is essential that the type and grading of the aggregate and proportions of the mix should be carefully chosen to give good workability, that the materials should be batched with care (preferably by weight) and that good supervision should be provided to ensure that the concrete is thoroughly compacted without being made too wet. Vibration assists in obtaining good compaction.

Curing is an important factor in obtaining good quality concrete and in reducing shrinkage. At normal temperatures the concrete should be maintained in a damp condition from the time it is laid for a period of at least three days and preferably for seven days. At low temperatures, say less than 40° F., these periods should be doubled. It is, of course, essential to prevent concrete freezing during the curing period.

NOTES ON THE CONSTRUCTION OF FINISHES

The construction of most types of floor finish requires skill and experience if satisfactory results are to be obtained and it is best carried out by one of the many firms who specialize in this type of work. This applies particularly to finishes such as cement-bitumen, cement-rubber latex, magnesium oxychloride or wood blocks; but even concrete finishes such as granolithic present difficulties in technique and the best results are generally achieved when specialist firms are employed on the work. Codes of Practice should be followed whenever applicable and the materials used should conform to the requirements of appropriate British Standard. (See Appendix).

Granolithic concrete

The chief difficulty to be overcome in laying a granolithic finish is that of obtaining a good bond between the finish and the main concrete floor. If the finish is applied before the base concrete has hardened no difficulty should be encountered, but if the base concrete has already hardened special precautions should be taken to ensure adequate bond. If the existing concrete has a smooth finish it should be roughened by picking to expose a fresh face and thoroughly cleaned with stiff brushes to remove dust and dirt. Some time before the finish is laid, preferably overnight, the floor should be well soaked with water and the excess water removed just before the finish is applied. A thin layer of stiff cement grout should be thoroughly brushed into the surface a few minutes before the finish is applied. It is important that the finish should be thoroughly rammed into contact with the base concrete to ensure proper bond.

The granolithic concrete generally consists of a mix of about 1 : 1 : 2 by weight, using a $\frac{3}{8}$ in. or $\frac{1}{4}$ in. crushed rock coarse aggregate, clean and free from dust, and either a natural or a crushed rock sand. Aggregates for granolithic floors are covered by B.S. 1201.

The water content in the mix should be kept as low as possible consistent with workability. This mix should be laid in alternate bays about 9 ft. square and compacted with a wooden straight-edge to screed battens or ebonite strips. After compacting, the surface should be lightly trowelled.

The topping should then be allowed to stand until such time as it has set sufficiently to withstand a final hard trowelling. Any laitance that collects on the

trowel should be removed and not trowelled back into the floor topping. This will ensure that the coarse granite which constitutes the wear resisting element in the floor is kept as close to the surface as possible.

FINISHING BY GRINDING: If the granolithic finish is to be ground, the grinding should be delayed sufficiently to prevent dislodgement of aggregate particles. It is best to use a power operated grinding machine shod with rapid-cutting abrasive stones, and the floor should be kept wet during the process. All material ground off must be removed by squeegeeing and flushing with water. After the first grinding, air holes, pits and other blemishes should be filled with a cement grout of creamy consistency. This should be spread over the surface and worked into the pits with a steel straight-edge and then rubbed into the floor surface with the grinding machine. The floor should be kept moist for three days to allow the grout to harden. It is then ground once more to remove the film and to give a polish and is thoroughly washed.

Metallic aggregate concrete

Granulated metal has for some years been used as an aggregate in floor and road surfacing. These aggregates can be obtained in different gradings, equal in particle size to fine sand, particles passing a $\frac{1}{8}$ in. sieve and those passing a $\frac{3}{16}$ in. sieve. A number of proprietary brands are on the market.

The finish, which should be $\frac{1}{4}$ in. to $\frac{3}{8}$ in. thick, should be laid before the concrete base has hardened.

Non-slip and special wear-resisting materials

It is sometimes advisable to include " abrasives " in the surface of concrete floors. The materials commonly used for this purpose are either silicon carbide (in grain form) obtainable commercially as " Carborundum " or " Crystolon " or under other names, or aluminium oxide (in grain form) obtainable commercially as "Alundum " or " Commercial floor grit A." The material should be graded between size No. 10 and size No. 30, the usual sizes being 20 to 26.

There are two methods of application in general use. The " abrasives " may either be mixed with the cement or may be sprinkled evenly on the surface and lightly trowelled in. For this purpose, a $\frac{1}{2}$ in. sieve may be used, fitted with a piece of brown paper with holes about $\frac{1}{4}$ in. diameter punched 1 in. to $1\frac{1}{2}$ in. apart.

When the " abrasive " is mixed with the cement it should be used in the following quantities :

Thickness of finish		*Weight of grain*	
$\frac{3}{4}$ in.		4 lb.
1 in.	(*per sq. yd.*)	6 lb.
$1\frac{1}{2}$ in.		$7\frac{1}{2}$ lb.
2 in.		9 lb.

When it is sprinkled on to the surface the weight of " abrasive " grain should be :

For heavy duty floors : $2\frac{1}{2}$ to $6\frac{3}{4}$ lb. per sq. yd. Average $4\frac{1}{2}$ lb.

For light duty floors : $\frac{1}{2}$ to $3\frac{1}{2}$ lb. per sq. yd. Average 2 lb.

Precast concrete slabs can be obtained with special metallic and non-slip aggregates incorporated in the surface. The most usual size is 12 inches square and from $1\frac{1}{4}$ in. to 2 in. thick.

Hardeners

A properly laid concrete floor does not give trouble from dusting or undue wear, but sometimes it is necessary to treat a floor to prevent dusting and to increase the hardness of the surface. Materials used for this purpose include silicate of soda, zinc silico-fluoride and magnesium silico-fluoride. A number of proprietary hardeners are also available which should be applied according to the makers' instructions.

Whichever of these materials is used the floor must be thoroughly clean and dry when it is applied. With new floors a thorough brushing with a stiff broom is probably all that will be necessary, but old floors should be scrubbed with soap and water and any adherent material on the surface should be removed with a wire brush. If the floor is very oily the oil stains may have to be removed.

SILICATE OF SODA: Silicate of soda is obtainable in various grades, but except on floors having a very low absorption the grade known as " P84. " should be used. This should be diluted with four times its volume of water and applied to the floor with a watering can or spray, afterwards being spread evenly with a mop or brush. Twenty-four hours later a second application should be made and if the floor still appears to be porous a third or fourth application should be given.

Any excess of liquid on the floor after this last coat has been absorbed should be removed and the floor allowed to dry. It should then be washed with plain water.

ZINC AND MAGNESIUM SILICO-FLUORIDE: Either of these two chemicals may be used alone, but a mixture of one part zinc silico-fluoride to four parts of magnesium silico-fluoride usually gives the best results. For the first application the solution should be made up at the rate of $\frac{1}{2}$ lb. silico-fluoride per gallon of water and for subsequent coats the strength of the solution should be 2 lb. per gallon.

The solution should be used in the same way as silicate of soda and the successive coats applied until there is little or no absorption. After the last coat has

dried the floor should be washed down.

During the use of silico-fluorides it is possible that hydrogen fluoride gas may be given off which may be dangerous to the eyes or open wounds. If these materials are being used indoors the room should be well ventilated and the operators warned to cover all cuts. Protection of the eyes is not normally necessary but if smarting should occur the operators should be taken off the work or protection given.

Coverage

It is difficult to give figures for the amount of hardening solution required as so much depends upon the porosity and general condition of the floor surface. An approximate rule is to allow one gallon of diluted solution for every twenty square yards of floor for each coat.

Maintenance

DUSTING: As stated above, a well-made concrete floor should not " dust " under normal wear. " Dusting " is, however, a relative term. What may not be noticeable in a factory becomes very objectionable in a paint shop or laboratory. In such cases the possibility of dust formation should be guarded against by the application of a hardener, and if thought necessary by subsequent treatment with wax, oil, or a solution of oil in spirit. Linseed oil and tung oil (chinawood oil) of the kind used for paint, either raw or boiled, and either alone or mixed with an equal amount of turpentine, have been found to be effective. Wax polish is another alternative.

PAINTING: Paints with a chlorinated rubber base are the most suitable for concrete floors. The floor must be quite clean and dry and free from any form of grease or oil.

WAX POLISH: Several very good types of proprietary polish are available with suitable primers, but a polish can be made by dissolving melted beeswax in turpentine at the rate of 6 oz. per pint and stirring into the solution 4 oz. of pigment (iron oxide for red or brown and chromic oxide for green). Before applying the polish the floor must be clean and dry. The wax should harden for about twelve hours and the surface should then be sprinkled with French chalk and polished with a soft dry cloth. The quantities given should be sufficient to cover an area of from three to four square yards.

ROUGHENING SMOOTH CONCRETE FLOORS: Concrete surfaces may become too smooth after extended use. They can sometimes be roughened by treatment with acid or by mechanical means.

The method most usually employed, if conditions permit, is to brush on to the surface a solution of muriatic acid (commercial concentrated hydrochloric acid or spirits of salts) made by diluting the concentrated acid with five times its volume of water. Slaked lime should previously be placed in any drains or gullies which might be damaged. The acid should be left on for about a quarter of an hour, the surface being brushed meanwhile with a stiff bass or wire broom. The quantity required is half a pint of solution per square yard. If drainage is difficult the floor may instead be covered with about $\frac{1}{2}$ in. sawdust soaked in the solution and left for some hours. The floor should be thoroughly washed with clean water after treatment.

Mechanical roughening is expensive but very effective. It is done with pneumatic or electric hammers operating with either " bush hammer " or " rose bit " tools.

Stain removal

IRON STAINS: Light iron stains may be removed by a solution of 1 oz. of sodium citrate in 6 oz. of lukewarm water, made into a paste with whiting, applied with a trowel and scraped off when dry. Alternatively, cotton-wool may be dipped in the solution and left on for half an hour. After the wool has been removed a pat of whiting and water sprinkled with sodium hydrosulphite crystals should be applied to the stain. Heavy contamination, however, is difficult to remove.

Copper and bronze stains can be removed with a paste made as follows : A dry mixture of 1 oz. powdered ammonium chloride (sal amoniac) and 4 oz. powdered talc (French chalk) is wetted with a solution made by diluting concentrated ammonia solution (S.G. 0.880) with ten times its own volume of water. The paste should be spread $\frac{3}{8}$ in. thick over the stain and allowed to dry. It is then scraped off, the surface washed and the process repeated if necessary.

INK STAINS: Ink stains can be bleached by the following method. Stir $\frac{1}{2}$ lb. bleaching powder (chloride of lime) into $\frac{1}{2}$ gallon of water, allow to stand for twenty-four hours, pour off the clear liquid and strain. Add to this $\frac{1}{2}$ oz. of glacial acetic acid. Soak a piece of flannel in this liquid, place on the stain and cover with glass or slate to prevent evaporation. Where the ink has penetrated deeply, or has dried to a solid crust the bleach solution should be allowed to remain in contact for a considerable time.

There are also available proprietary products for the removal of stains. Names of manufacturers will be supplied on request.

APPENDIX

List of British Standards and Codes of Practice.

BRITISH STANDARDS

368 : 1936	Precast concrete flags in Portland cement.
776 : 1938	Materials for use in the manufacture of magnesium oxychloride flooring composition.
810 : 1938	Plain linoleum and cork carpet.
882 : 1944	Coarse and fine aggregates from natural sources for concrete.
1014 : 1942	Pigments for colouring cement, magnesium oxychloride and concrete.
1018 : Part I 1942	Timber in building construction : floors.
1067 : 1942	Coal tar pitch felt damp-proof courses.
1076 : 1942	Mastic asphalt for flooring.
1097 : 1943	Mastic asphalt for damp-proof courses and tanking.
1177 : 1944	Pitch mastic flooring incorporating lake asphalt.
1187 : 1944	Wood blocks (interlocking) for floors.
1197 : 1944	Concrete flooring tiles and fittings—dimensions and workmanship.
1201 : 1944	Aggregates for granolithic concrete floors.
1286 : 1945	Clay tiles for flooring—dimensions and workmanship only.
1297 : 1946	Grading and sizing of softwood tongued and grooved flooring.
1324 : 1946	Asphalt tiles for paving and flooring—natural rock asphalt.
1325 : 1946	Asphalt tiles for paving and flooring—mineral aggregates with no inherent bitumen.
1375 : 1947	Coloured pitch mastic flooring.
1410 : 1947	Mastic asphalt flooring—natural rock containing 6–10 per cent. bitumen.
1450 : 1948	Pitch mastic flooring.

CODES OF PRACTICE

201	**Timber flooring.**
201.101	Hardwood and softwood board and strip.
201.102	Wood block.
201.103	Plywood.
202.	**Tile and slab flooring.**
202.101	Clay and concrete brick and tile.
202.102	Natural and cast stone.
202.106	Composition block (*in preparation*).
203.	**Sheet flooring** (*in preparation*).
203.101	Linoleum and cork carpet.
203.102	Cork tile.
203.103	Asphalt tile (*deferred*).
203.104	Rubber flooring.
204.	**Jointless flooring** (*in preparation*).
204.101	Concrete (plain granolithic).
204.102	Terrazzo flooring.
204.103	Asphalt mastic flooring.
204.104	Pitch mastic flooring.
204.105	Cement rubber latex.
204.106	Cement bitumen (*tentative*).
204.107	Magnesium oxychloride composition.
204.108	Calcium sulphate.

The Cement and Concrete Association

Users of cement and concrete have available to them a free and impartial service of technical information and advice based equally on long practical experience and on the findings of a modern Research Station. Inquiries should be sent to the Cement and Concrete Association, 52 Grosvenor Gardens, London, SW1 (or in the case of Scotland to 22, Rutland Square, Edinburgh) where they will be answered by its research, its architectural or its engineering officers. If it is not possible to deal with a problem by correspondence, arrangements can often be made for a technical officer of the Association to visit the work in progress. This service is an important part of the work of the Association, which comprises, in addition to research, education, the promotion of better concreting practice, the study of new uses of the material and the publication of both popular and scientific booklets and bulletins.

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